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PULLING TEETH: WHY HUMANS ARE MORE IMPORTANT THAN HARDWARE IN AIRBORNE INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE

by

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A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The content of this paper reflects my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes.

Signature: ______________________

13 April 2015

Thesis Adviser: Signature: ______________________
S. Michael Pavelec, Ph.D., Assoc. Professor

Approved by: Signature: ______________________
Steven Guiliani, CAPT, USN
Committee Member

Signature: ______________________
Robert M. Antis, Ph.D.
Director, Joint Advanced Warfighting School

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ABSTRACT

The expanded development and employment of unmanned aerial systems (UAS) places a disproportionate focus on the importance of technology over humans in airborne intelligence, surveillance, and reconnaissance (ISR) operations. The surge of airborne ISR in Iraq and Afghanistan since 2008 solidifies the importance of manned ISR aircraft and aircrews. Manned airborne ISR provides an indispensable combat capability because technology alone cannot replace the situational awareness, analytical decision reasoning, and flexibility of human ISR aircrew. Airborne ISR in future war will require a mixed fleet of both manned and unmanned aircraft to leverage the complementary strengths and capabilities of each system to maximize airborne ISR effectiveness in increasingly complex operational environments. As history has shown, unmanned technology will continue to complement and empower human aircrews, not replace them. War is an inherently human endeavor that will always require people on and over the battlefield.

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Chapter 1. Introduction

I've been wrestling for months to get more intelligence, surveillance, and reconnaissance assets in theater. Because people were stuck in old ways of doing business, it's been like pulling teeth.
(Former) Secretary of Defense Robert M. Gates, April 21, 2008

Airborne intelligence, surveillance, and reconnaissance (ISR) operations are an indispensable part of modern war. They provide critical information that guides decision making, targets threats, and saves lives on the battlefield. Airborne ISR comes in all shapes and sizes from large four-engine jets to small turbo-prop airplanes to even smaller unmanned aircraft. Constant improvements in tactics, techniques, and technology have made airborne ISR one of the most powerful forces in the battlespace. That success has also created a seemingly insatiable demand for airborne ISR across the globe as exemplified by combat operations in Iraq and Afghanistan.

Despite unprecedented ISR coverage, both combat theaters had many unfilled intelligence requirements as the demands of war exceeded the supply of available ISR assets. This demand prompted former U.S. Secretary of Defense Robert Gates in April 2008 to publicly criticize the U.S. military, specifically the Air Force, for its seemingly tepid effort to push more ISR to Iraq and Afghanistan.[1] Secretary Gates promptly created a task force to address the issue, and the resulting solution led to one of the largest increases of airborne ISR in history, including a surge in manned platforms. As over a decade of war has proven, the situational awareness and understanding of human aircrews to analyze and respond to the operational environment makes manned airborne ISR a critical combat capability that technology alone cannot fully replace.

Airborne ISR History.

Historically, airborne ISR has been performed by humans; seventeenth century accounts

[1] U.S. Department of Defense news transcript, "Secretary Gates Remarks at Maxwell-Gunter Air Force Base, Montgomery Alabama" (April 21, 2008). http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4214 (accessed December 20, 2014).

describe man-lifting kites in the Far East while eighteenth and nineteenth century manned balloons and piloted fixed wing aircraft in the twentieth and twenty-first centuries provided this capability. One of the first recorded Western uses of manned balloons for ISR purposes occurred in the 1794 Battle of Fleurus during the Wars of the French Revolution. In the American Civil War, the Union and the Confederacy both sent soldiers aloft in tethered hot air balloons to observe enemy positions on the battlefield. The Union Army even established a separate Balloon Corps from 1861 to 1863. Manned airborne ISR efforts continued into the twentieth century with German Zeppelins and new fixed wing aircraft flying reconnaissance during World War I. By the end of World War II, manned airborne ISR had become a mainstay of military operations. The ISR demand increased throughout the Cold War, as manned ISR airplanes often became the only source of intelligence regarding Soviet military capabilities and force posturing.

The successful launch of *Sputnik* in 1957 created a paradigm shift in airborne ISR as space presented a new domain with potentially greater reach and less risk to humans and airplanes. Three years later, this risk escalated into an international incident when a U-2 piloted by Francis Gary Powers was shot down by a surface-to-air missile over the Soviet Union. After *Sputnik*, the ensuing Space Race between the Americans and the Soviets expanded the use of satellites as a growing source of ISR. However, due to their high cost, limited numbers, and episodic coverage, satellites were a complement to rather than a replacement for manned airborne ISR systems. Technology has advanced tremendously since the 1950s, but space-borne ISR systems still lack the comparative depth and overall flexibility to wholly replace manned "air breathing" ISR systems because of their cost, complexity, and physical employment limitations.[2] The advent of unmanned aerial systems (UAS), however, has reinvigorated the man versus machine

[2] Matt Alderton, "Airborne ISR: The Wave of the Future isn't just about Collecting Data – It's Finding Better Ways to Exploit It," *Trajectory Magazine* 4 (2013), http://trajectorymagazine. com/2013-issue-4/item/1623-airborne-isr.html (accessed September 4, 2014).

debate for airborne ISR in future war. While UASs have become the asset of choice for a number of airborne ISR missions, manned platforms remain the best option for many others. The factors that drive these latter types of missions are the focus of this thesis.

Research Problem.

Manned airborne ISR is more important now than ever, particularly in the ongoing fight against unconventional and elusive enemies. Aircrews flying aboard ISR aircraft provide a powerful synergistic effect by analyzing real time data from multiple sources and making immediate decisions on the aircraft that guide decision making and other operations in the battlespace. The tasks that comprise the analytical processes of ISR cross-cueing and crew resource management are complex and become increasingly difficult when confronted with time delays and distance. Aircrews flying directly overhead, not separated by thousands of miles or communication link delays, bring an enhanced level of situational awareness and battlespace responsiveness. However, many take this value for granted by simply assuming UASs can do everything manned platforms can do. The problem with this view is that it overlooks the synergistic importance of the human dynamic. The expanded development and employment of UASs often places a disproportionate focus on the value of technology over humans in airborne ISR. The assumed predominance of UASs risks overall ISR effectiveness by discounting the importance of manned airborne ISR in joint theater campaign planning for future war.

Thesis and Relevance.

This thesis contends that manned airborne ISR will remain crucial in future war, and that unmanned aircraft will not completely replace the need for human aircrews to fly onboard aircraft to execute ISR missions. Manned and unmanned platforms each bring sets of strengths and limitations to the joint force that must be properly understood and carefully considered since

a limitation of one may be offset by a strength of the other. Airborne ISR in future war will require a mixed fleet of both manned and unmanned aircraft purposely linked at the strategic and theater operational levels to successfully execute diverse mission sets within increasingly complex operational environments.

Airborne ISR is a key component of the Combatant Commander's (CCDR) theater campaign and contingency planning and execution. It is also a vital part of the larger national and joint community that transcends a single military branch of service or component. Intelligence is an established joint function, and surveillance and reconnaissance make up key components of the intelligence function supporting the full range of military actions in the Joint Force Commander's (JFC) operational area.[3] As such, it is important for decision makers, planners, and analysts to understand the advantages (and in some cases, the necessity) of using both manned and unmanned airborne ISR rather than relying strictly on unmanned systems. CCDRs will require a mixed fleet to fulfill strategic collection requirements, achieve operational objectives, and conduct tactical operations during theater campaign and contingency planning and execution. Much of the current subject literature focuses on advancements in technology without adequately discussing the corresponding benefits of using human aircrews in ISR operations. This argument more fully analyzes what makes manned airborne ISR systems an invaluable and necessary component of current and future war.

Scope and Limitations.

Due to the complexity and breadth of airborne ISR operations, several related topics exceed the scope of this paper and will not be discussed in depth. Even though unmanned aircraft are remotely operated by humans, the specifics of UAS ground crew operations are only referenced for comparison purposes with manned systems. They are not analyzed in great detail since the

[3] Joint Publication 3-0, *Joint Operations*, III-21.

argument focuses on the value of ISR aircrew flying over the battlefield, not from a remote ground site. Since the human element is a key piece of the argument, (unmanned) spaceborne ISR systems and artificial intelligence (AI) technologies are referenced, but not specifically analyzed. The paper also does not discuss the processing, exploitation, and dissemination (PED) of airborne ISR data that often occurs offboard the aircraft. While PED is crucial in turning raw collected data into actionable intelligence, the paper only discusses the initial analysis and cross-cueing fusion done by the ISR aircrew in real-time onboard the aircraft. Finally, the paper does not fully analyze the use of armed manned and unmanned ISR aircraft in detail. This topic, particularly the debate over targeted counterterrorism strikes conducted by UASs, is well documented in other sources and exceeds the focus and purpose of this paper.

The examples presented in the following chapters are drawn primarily from U.S. Air Force and Army operations in Iraq and Afghanistan. Limiting the discussion to those theaters covers the preponderance of airborne ISR operations, and it allows equitable analysis of times, places, and organizations where both manned and unmanned systems were used in comparable efforts. It also underscores the current and future relevance of understanding what makes airborne ISR operations successful. In the upcoming chapters, the argument addresses the historical and current circumstances affecting the growth of manned and unmanned ISR systems.

Chapter Outline.

Chapter 2 explores some of the technical, economic, and political factors behind the increased use of UASs, specifically medium-altitude long endurance platforms after 9/11. It discusses how UASs complemented, but did not wholly replace, manned systems. Chapter 3 discusses how the number of manned ISR platforms and aircrew increased alongside UASs to meet surging mission requirements in Iraq and Afghanistan. It explains why UASs alone are not enough to fulfill the

demand for airborne ISR by showing how human aircrews' situational awareness and understanding are superior to unmanned technology in responding to complex operational environments. After establishing a discussion baseline for airborne ISR, the paper compares and contrasts manned and unmanned ISR capabilities and makes recommendations for future war.

Chapter 4 analyzes the strengths and limitations of manned and unmanned ISR by exploring human and technological aspects. Through this analysis, the paper illustrates when and why it is more effective to use manned platforms. Chapter 5 discusses why human ISR aircrews will remain important even though continual advancements in technology may close much of the current technical gap between manned and unmanned systems in the future. The analysis shows that manned airborne ISR will always be indispensable because of the unmatched situational awareness and responsive analytical power of humans. In the end, the thesis concludes that future airborne ISR will require a mixed fleet of both manned and unmanned systems. Both provide complementary capabilities that must be employed together to maximize effectiveness. UASs will continue to empower human aircrews, not replace them. War is an eternal human endeavor that will always require people on and over the battlefield.

Chapter 2. Rise of the Machines

We have just won a war with a lot of heroes flying around in planes. The next war may be fought by airplanes with no men in them at all."

General Henry H. "Hap" Arnold, USAAF, 1945

The Historical Rise and Fall of Unmanned Airborne ISR

Sometimes referred to as unmanned aerial vehicles (UAV), remotely piloted aircraft (RPA), or generically as "drones," unmanned aerial systems (UAS) and their early predecessors can be traced back over 2,000 years. Although it is difficult to verify the exact origins, kites appear to be the first use of unmanned aviation for military purposes. In the second century B.C., Chinese General Han Hsin reportedly used kites while laying siege to an enemy fortress.[1] Based on trigonometry, he calculated the distance from his forces to the enemy based on the length of kite string required to fly over the fort's walls. Chinese sappers used this information to determine the distance they needed to tunnel under the walls and surprise the enemy defenders.[2] Other instances of "kite ISR" can be found spread throughout history until the emergence of balloons. The first recorded Western use of unmanned balloons in military operations occurred in 1849 during the First Italian War of Independence when Austria used explosive-laden balloons to attack Venice, Italy. Despite the intermittent use of unmanned aircraft of one type or another since then, unmanned airborne ISR did not progress in earnest until much later. Even then, its emergence was more the result of unexpected circumstances rather than deliberate planning.

The Powers shootdown in 1960 and subsequent political fallout created the first real impetus to take some of the demands and risks of airborne ISR off manned platforms. The incident accelerated the use of satellites for reconnaissance, but it also led to the development of early

[1] David Pelham, *The Penguin Book of Kites* (London: The Penguin Group, 1976), 8.
[2] Lee S. Newman and Jay H. Newman, *Kite Craft: The History and Processes of Kitemaking Throughout the World* (New York: Crown Publishers, Inc., 1974), 2.

UASs like the Red Wagon as well as additional manned aircraft like the SR-71 Blackbird.[3] The loss of another U-2 during the 1962 Cuban missile crisis eventually led to the creation of a drone reconnaissance program, but unmanned ISR advancement remained slow.[4] Another politically seminal event in the UAS evolution timeline occurred in April 1968 when North Korea downed a U.S. EC-121 reconnaissance plane in international airspace over the Sea of Japan, killing all 30 American aircrew onboard.[5] The resulting domestic outcry against the Nixon administration encouraged further UAS fielding for strategic collection, but the emphasis remained on satellites and proven manned platforms, relegating UASs to third place for ISR.[6] Despite the setbacks, unmanned ISR research and development continued throughout the Cold War years, but poor integration and priority challenges hindered the nascent UAS acquisition process.

During the early Cold War years, the national intelligence community and other U.S. government agencies drove much of the research, development, and fielding of UASs to meet emerging requirements during an extremely sensitive time in U.S. history. As a result, early UAS management can be likened to "black" program development since it had minimal oversight or direction, especially when compared to other more established airborne ISR efforts.[7] This kind of secretive and flexible management was necessary given the context of the operational environment at the time, but it presented a double-edge sword for UAS procurement. On the one hand, so-called "black" funding and development methods allowed maximum freedom and flexibility to quickly develop and employ new technologies. On the other, it also made UAS programs more difficult to transition to mainstream baseline funding and acquisition.

[3] Thomas P. Ehrhard, "Air Force UAVs: The Secret History," PhD diss., Mitchell Institute for Airpower Studies (2010), 6.
[4] *Ibid.* 23.
[5] Larry Tart and Robert Keefe, *The Price of Vigilance: Attacks on American Surveillance Flights* (New York: Ballantine Books, 2001), 15.
[6] Ehrhard, 12.
[7] *Ibid.* 5-7.

During the Vietnam War, UASs finally found an operational niche as their focus changed from strategic collection to more tactically focused ISR missions. The extensive use of Soviet-provided air defenses in North Vietnam and increasingly restrictive rules of engagement increased the physical and political risks to U.S. aircrew during certain missions. This opened the door for a wider employment of UASs, especially in denied areas, where they steadily proved their worth as a valuable complement to manned ISR assets.[8] The most successful systems, such as the Air Force's Lightning Bug, showcased capabilities in photo reconnaissance, electronic intelligence, and as decoys to enemy air defenses. At the peak of U.S. air operations in Vietnam, UASs were an established part of the first mixed fleet of manned and unmanned airborne ISR.[9]

By the early 1970s, however, UAS operations culminated. After seeing extensive action in Vietnam, many UAS programs were considered extravagances that were no longer needed. Because of its secretive funding and operations, unmanned airborne ISR was not as widely understood as traditional manned operations, leading to further misperceptions about the true utility and future potential of UASs.[10] This set the stage for the rocky operational transition of UASs to the European theater. Operating UASs in the comparatively unfettered airborne environment over much of Southeast Asia proved vastly different than the new challenges confronting ISR operations in Central Europe. Poor weather, congested airspace, and Allied interoperability highlighted some of the inherent limitations in the unmanned ISR systems coming out of Vietnam. UAS sensor, data link, and sortie generation capabilities all fell short of mission requirements in the demanding European theater. High operating costs, chronic program budget overruns, and non-integrated acquisition processes exposed the prevalent myth of UAS

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[8] Ehrhard, 25.
[9] *Ibid.* 26.
[10] P.W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin Books, 2009), 55.

affordability, leading to a significant divestment in unmanned ISR over the decade.[11] As the Vietnam wartime budget dried up in the 1970s, it became more difficult for the previously unconstrained UAS programs to fit within competitive peacetime budgets. Despite the risk of losing aircrews in the Cold War, the technical and economic risks of relying on comparatively immature UASs made them incapable of consistently meeting U.S. national requirements.[12]

After UASs such as the U.S. Navy and Marine Corps RQ-2A Pioneer conducted operations during Desert Storm and Somalia, the UAS comeback began in Southeast Europe. In 1994, a new quick reaction capability program known as the RQ-1 Predator made its first military deployment supporting U.S. operations in Bosnia-Herzegovina.[13] The Predator's Balkans debut provided an invaluable opportunity in a relatively benign operational environment to test and demonstrate the new platform's technology and reinvigorate UAS development. Five years later, after gaining additional operational experience over Iraq in Operation SOUTHERN WATCH, the Predator saw its most extensive use to date during Operation ALLIED FORCE over Serbia and Kosovo. However, limited sorties, mechanical and operator difficulties, and inherent system growing pains curtailed its usage during the 78-day air campaign, but many commanders and joint planners recognized the potential.[14] As in the Cold War, unforeseen circumstances again propelled the next big advancement in UAS development.

UASs after 9/11.

September 11, 2001 and the start of the Global War on Terror (GWOT) signaled the true beginning of the unmanned ISR resurrection. The U.S. had been involved in counterterrorism (CT) and counter-insurgency (COIN) previously, but the scope and asymmetric complexity of

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[11] Ehrhard, 35-36.
[12] *Ibid*. 36-37.
[13] *Ibid*. 50.
[14] Paul J. Springer, *Military Robots and Drones* (Santa Barbara: ABC-CLIO, LLC, 2013), 194.

irregular warfare in the GWOT strained every facet of U.S. military doctrine and capability. The nature of the GWOT, in turn, presented a golden opportunity to showcase the strengths of UASs. Finding highly mobile and elusive terrorists and insurgents hiding in complex mountainous and urban terrain demanded persistence for target development and identification.[15] Due to their inherently long loiter times, UASs are well-suited to provide persistent ISR by maintaining enduring coverage of known or suspected targets and areas of interest.

Persistent ISR has been an enduring military requirement since the Cold War, but satellites and manned platforms provided only intermittent or limited coverage. To mitigate these gaps, U.S. planners and analysts developed ways to maximize available ISR collection through tailored analysis and other intelligence sources. For example, ISR coverage of large, static targets such as airfields or military garrisons often only required basic change detection analysis to meet requirements. If there was not enough fidelity on a particular target, other sources such as human intelligence (HUMINT) could complement what was collected by airborne ISR. As targets, such as Soviet nuclear missiles operating away from traditional fixed sites, became more mobile and dispersed, there was a greater demand for ISR persistence. Again, U.S. intelligence personnel and decision makers were able to mitigate this challenge through other sources and methods that allowed more time to locate targets for strategic assessments. The end of the Cold War, however, posed new challenges for airborne ISR as complementary sources like HUMINT decreased and adversary targets became even more elusive and fleeting.

The need for greater ISR persistence to rapidly locate fleeting targets was painfully evident while hunting Iraqi Scud missiles during Desert Storm and Serbian surface-to-air missiles during ALLIED FORCE. After 9/11, the ISR dynamic changed for good when hunting small bands of highly mobile and concealed terrorists and insurgents across the world made persistence a must-

[15] Michael T. Flynn et al., "Employing ISR: SOF Best Practices," *Joint Forces Quarterly* 50, (3rd Quarter 2008), 57.

have capability. The enemy blended in with the surrounding civilian population with few traditional telltale signs of their presence such as military equipment or conventional troop movements and communications. Finding and fixing enemy targets hidden in sprawling cities, expansive deserts, dense jungles, or mountainous caves presented a daunting task. Finding a proverbial needle in a haystack demanded airborne ISR persistence. In the Cold War, the Soviets had been easy to find, but hard to kill. The adage was now flipped in the GWOT, as terrorists proved to be comparatively easier to kill, but much harder to find.[16] This challenge is especially prominent during intensive airborne ISR man-hunts targeting high value individuals (HVI). In the ISR cycle of finding, fixing, and finishing targets, it can take an inordinate amount of time and resources to find and fix elusive targets like HVIs. Finishing these targets, by comparison, often requires substantially less effort. For example, the 2006 operation targeting Abu Musab al-Zarqawi, the head of Al Qaeda in Iraq, took over 600 hours of airborne ISR to find and fix his location. After fully developing the Zarqawi network target, it only took about ten minutes for U.S. F-16s to eliminate the terrorist leader.[17]

UAS Growth in the GWOT.

Since 2001, the number of dedicated UAS ISR operations has skyrocketed in Afghanistan, Iraq, Africa, and other locations as part of the GWOT. The insatiable demand for airborne ISR, especially persistent full motion video (FMV) coverage, made UASs like the Predator one of the most heavily tasked assets of the entire war. Large flat screen televisions broadcasting non-stop Predator FMV became a mainstay in nearly every Coalition operations center and planning cell. The relentless focus on unblinking FMV was the primary driver behind the Department of

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[16] Richard K. Betts, *Enemies of Intelligence: Knowledge and Power in American National Security* (Columbia University Press, 2007), 8.

[17] David A. Deptula, "Information-age Warfare Demands New Approaches to ISR Structures," *Armed Forces Journal* (November 1, 2010), http://www.armedforcesjournal.com/think-different/ (accessed December 23, 2014).

Defense requirement to establish 65 round-the-clock UAS combat air patrols, also called orbits, by the end of fiscal year 2013. Ironically, this heavy demand negates much of the purported UAS advantage of reducing manpower requirements as compared to manned aircraft needs. Not counting additional UAS ground support personnel, each orbit requires four aircraft and 10 two-man crews to maintain continuous coverage, representing a staggering 1,200 percent increase in UAS operations since the war in Afghanistan began.[18] The explosive growth in unmanned ISR soon stretched UAS manpower and aircraft capacity to the limit.

Up to this point, the majority of RPAs were flown by qualified Air Force officer pilots pulled from the cockpits of various manned aircraft across the service. Similarly, the RPA sensor operator crew members, comprised of enlisted personnel, had also often been taken from manned platforms. Building up to and then sustaining the 65-orbit requirement using personnel primarily from manned aircraft rapidly became untenable, forcing the Air Force to revamp its entire RPA manning construct. In 2011, the Air Force officially unveiled a new career field and training program to create dedicated RPA crews.[19] As a result, the total number of Air Force personnel conducting and supporting UAS operations since 2005 are expected to quadruple by 2017 from 2,100 to 9,900. A significant milestone was reached in fiscal year 2012 when the Air Force, for the first time in its history, trained more RPA operators than fighter and bomber aircrew combined.[20] The Air Force's new RPA schoolhouse will help ease these growing pains and give more flexibility to organize, train, and equip UAS operations going forward.

By 2008, the U.S. defense industry faced similar changes to provide more airframes to meet the surging demand for unmanned airborne ISR. General Atomics Aeronautical Systems, the

[18] Aaron Church, "RPA Ramp Up," *Air Force Magazine* Vol. 94, No. 6 (June 2011), 58.
[19] *Ibid.* 59.
[20] Headquarters, United States Air Force, *RPA Vector: Vision and Enabling Concepts 2013-2038* (February 17, 2014), 18.

primary defense contractor for Air Force and Army medium-altitude RPAs, was reportedly making MQ-1 Predators and MQ-9 Reapers at the company's maximum production capacity.[21] Since the supply capacity could not keep up with demand timelines, the U.S. Department of Defense looked to other sources for airborne ISR combat power. General Atomics, however, disputed that assertion by claiming they had as much as 70 percent production capacity to spare based on the capability of their newest assembly facility. A senior company president insisted their UAS production capability had "nothing to do" with the eventual Department of Defense decision to pursue other methods to meet ISR requirements.[22] While this comment could imply a number of potential factors, it can certainly be linked to some of the historical complications with UAS acquisition. However, while acquisitions and funding remain continual challenges to UAS numbers and fielding, they have less of an impact on overall UAS capabilities, especially when compared to the ability of human aircrews flying aboard ISR aircraft.

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[21] John A. Tirpak, "Lifesaving Liberty," *Air Force Magazine* Vol. 94, No. 4 (April 2011), 53.
[22] Robert W. Moorman, "ISR: Manned vs. Unmanned," *C4ISR Journal* (June 2009), 30.

Chapter 3. More Eyes in the Sky…The ISR Aircrew Surge

A human sitting in a box (on the ground) can't have the same kinesthetic awareness of an aviator sitting in a platform in the middle of combat.

General Mike Hostage, USAF, July 29, 2014

Manned Airborne ISR in History.

The value of humans flying aboard aircraft for intelligence, surveillance, and reconnaissance (ISR) is documented throughout history. Cultural folklore and undated ancient historical traditions from the Far East mention large kites lifting men to observe enemy positions on the battlefield. The first documented military account of man-lifting kites was by the Chinese and Japanese to monitor enemy forces in the seventeenth century.[1] During the Boer War in South Africa, Captain Baden-Powell of the Scots Guard tested man-lifting kites for the British Army and conducted successful flights hoisting observers to scout enemy lines. Despite Baden-Powell's initial success, his efforts were overshadowed by the British Army's balloon section.[2]

Manned balloons have been used for ISR in Western military operations since the eighteenth century Wars of the French Revolution. In the nineteenth century, the French also used manned balloons during the Franco-Prussian War to monitor troop movements and pass communications during the siege of Paris. By the early twentieth century, a British entrepreneur, Samuel Franklin Cody, had solidified a design to make man-lifting kites a potential ISR complement to manned balloons. Cody convinced the British Army that balloons would provide airborne ISR in light winds while kites were better in stronger winds.[3] Kites and balloons both remained in the British ISR inventory until the emergence of fixed-wing airplanes in the early twentieth century.

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[1] Harold Ridgway, *Kite Making and Flying* (New York: Gramercy Publishing Company, 1962), 142.
[2] Joseph J. Cornish III, "Go Fly a Kite," *Natural History*, April 1957, http://www.naturalhistorymag.com/htmlsite/editors_pick/1957_04_pick.html (accessed January 25, 2015).
[3] Percy B. Walker, *Early Aviation at Farnborough: The History of the Royal Aircraft Establishment, Vol. 1, Balloons, Kites and Airships* (London: Macdonald and Co. Publishers, Ltd, 1971), 114.

In 1911 during the Turco-Italian War, Italians flew fixed-wing ISR missions observing Turkish troops near Tripoli, Libya. During World War I, the role of manned ISR steadily grew from observation to airborne targeting as aircrews identified enemy forces for ground artillery fire. In the First Battle of the Marne, Allied ISR aircrew detected the exposed right flank of the German First and Second Armies and recognized that General Alexander von Kluck's forces were maneuvering to cut off Paris from the main French forces.[4] The crew passed this critical intelligence to Allied commanders who quickly positioned two French armies and the British Expeditionary Force to exploit the German vulnerability. The subsequent Allied counterattack marked the culmination of the German advance into France and set the stage for the ensuing stalemate in trench warfare that dominated combat on the Western Front.[5]

In World War II, ISR aircrew proved their worth time and again through timely airborne targeting and imagery intelligence (IMINT) analysis and reporting. Their analytical expertise expanded with the introduction of airborne signals intelligence (SIGINT), specifically communications intelligence (COMINT) and electronics intelligence (ELINT), when British linguists flew onboard bomber missions to analyze German radar networks and controller operations in North Africa in 1942.[6] The United States conducted similar efforts with their own airborne linguists against the Germans and the Japanese. In both cases, it was the situational awareness and responsiveness of the ISR aircrew to identify, prioritize, and report enemy activity that gave the Allies the crucial advanced warning that guided decisions and saved lives.

Airborne ISR aircrew flew countless hours throughout the Cold War, but "peacetime" strategic intelligence collection flights and analysis did not typically demand the same level of

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[4] Eric Lawson and Jane Lawson, *The First Air Campaign: August 1914-November 1918* (Conshohocken, PA: Combined Books, 1996), 11.
[5] Earle Rice, Jr., *The First Battle of the Marne* (Philadelphia: Chelsea House, 2002), 93.
[6] Aileen Clayton, *The Enemy is Listening* (New York: Ballentine Books, 1980), 212.

urgency and responsiveness required during active combat operations.[7] As a result, some ISR aircrew skills atrophied during the mass demobilizations immediately after World War II. Consequently, U.S. airborne ISR found itself woefully unprepared to provide immediate intelligence to commanders and combat forces at the onset of the Korean War. ISR aircrew again quickly adapted and built on COMINT experience gained during World War II. The crews' ability to rapidly analyze and integrate critical intelligence during operations such as "Mosquito Mellow," an early forward air controller and airborne command and control (C2) effort in Korea, reaffirmed the importance of having human ISR aircrew in the battlespace.[8]

In Vietnam, the need for immediate actionable intelligence from aircrew became even more important as restrictive rules of engagement hamstrung many operations throughout the war. American aircraft suffered increasing losses to North Vietnamese MiGs that continually held the information advantage in ambushing U.S. strike packages from their (politically enabled) sanctuary bases. ISR aircrews were pivotal in reversing this alarming trend as part of the widely successful Project Teaball. Multiple sources of intelligence analysis by U-2, RC-135, and EC-121 aircrew fed the Teaball network of ground, air, and naval controllers, enabling U.S. fighters to anticipate enemy actions and finally turn the tide in the air during the last years of the war.[9]

During Desert Storm in 1991, ISR aircrew onboard a then prototype E-8 Joint Surveillance Target Attack Radar System (JSTARS) detected Iraqi forces moving under cover of darkness toward the small Saudi border town of Khafji. The JSTARS crew quickly analyzed their moving target indicator radar data, recognized the enemy's intent, and coordinated with Coalition air and

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[7] Maj Tyler Morton, "Manned Airborne Intelligence, Surveillance, and Reconnaissance: Strategic, Tactical...Both?" *Air & Space Power Journal* (November-December 2012), 42.
[8] J. Farmer and M. J. Strumwasser, *The Evolution of the Airborne Forward Air Controller: An Analysis of Mosquito Operations in Korea* (Santa Monica: RAND Corporation, 1967), 38.
[9] Maj Gen Doyle E. Larson, "Direct Intelligence Combat Support in Vietnam: Project Teaball," *American Intelligence Journal* 15, No. 1 (Spring/Summer 1994), 57-58.

ground forces, enabling the Iraqi defeat and preventing the escalation of a ground war into Saudi Arabia. Twelve years later during the opening phase of Operation IRAQI FREEDOM (OIF), JSTARS aircrew again detected Iraqi forces setting an ambush south of Baghdad. This time, the Iraqis attempted to conceal their movement during a vicious sandstorm that had stalled the Coalition ground advance. JSTARS was the only ISR asset that could see through the weather with its unique ground-mapping radar, and its joint Air Force and Army aircrew are highly trained in analysis, C2, and coordination with air and ground forces. The direct connectivity via radio and data link with ground forces and commanders, coupled with the training, experience, and timely coordination efforts of the aircrew enabled 34 precision airstrikes, obliterating the Iraqi threat and saving Coalition forces from attack.[10] After 9/11, additional capability was needed to complement the high altitude, wide area coverage provided by larger manned ISR platforms such as the JSTARS, RC-135, and EP-3. Unmanned aerial systems (UAS) have filled part of that gap at medium and low altitudes, but manned light ISR aircraft with Army and Air Force aircrews have become integral to fulfilling the mission requirements.

The Airborne ISR Surge.

When Secretary Gates publicly chastised the Air Force for the lack of airborne ISR during his 2008 speech at the Air War College, he may not have anticipated a big part of the eventual solution. In August 2008, about 80 percent of the airborne ISR assets in the U.S. military inventory were already deployed for U.S. Central Command (CENTCOM) operations, mostly in Iraq and Afghanistan. The remaining ISR force was committed to other theaters or allocated for training and replacement spares, so there was not a dedicated reserve that could be quickly committed to the fight. In the manned aircraft community, the increased demand for airborne

[10] Unclassified excerpt from mission after action report by Maj John Werner, 116th Air Control Wing, Robins AFB, GA, June 2003.

ISR created the same challenges faced by the UAS community: getting enough people and planes to meet requirements. Based on his remarks, Secretary Gates seemed to believe a rapid increase in UASs was the best answer to get more airborne ISR.[11] However, manpower and hardware capacity, acquisition timelines, and combat capability factors proved otherwise. A template for a more immediate and comprehensively better solution had quietly been operating in Iraq for nearly two years.

Task Force ODIN.

As the situation in Iraq devolved into a brutal insurgency, improvised explosive devices (IED) emerged as the most lethal threat to Coalition ground forces. Locating and defeating the elusive IED networks required persistent, multi-source data that could be quickly turned into actionable intelligence on the battlefield. UASs, however, simply lacked the situational awareness and responsiveness to effectively counter the threats alone. In response, the U.S. Army established Task Force ODIN (Observe, Detect, Identify, and Neutralize) in 2006 to conduct ISR operations targeting the IED networks.[12] The unit had to be deployed and made operational as rapidly as possible, so TF ODIN personnel accomplished their urgent mission through an innovative pairing of new ISR technologies with manned and unmanned aircraft. Since the Army could not immediately increase its small fleet of Warrior-Alpha UASs or get additional help from the already over tasked Air Force Predators, the service turned to manned aircraft. Civilian Cessna aircraft and Army C-12s were readily available and quickly modified to carry advanced sensors and communications gear.[13] The Army had been flying C-12 variant for years, so they already

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[11] Robert W. Moorman, "ISR: Manned vs. Unmanned," *C4ISR Journal* (June 2009), 29-30.

[12] COL A.T. Ball and LT COL Berrien T. McCutchen Jr., "Task Force ODIN Using Innovative Technology to Support Ground Forces," *Combat Aviation Brigade Public Affairs* (September 20, 2007), http://www.dvidshub.net/news/printable/12463 (accessed December 23, 2014).

[13] *Ibid.*

had an experienced cadre of aircrew to help speed up the transition. Once deployed, the unique mix of manned and unmanned airborne ISR produced results even better than expected.

TF ODIN's basic concept used UASs to provide persistent full motion video (FMV) coverage over locations most prone to IED attacks to help develop enemy pattern-of-life data to prioritize target areas. TF ODIN's aircrew then provided the critical sensor-to-shooter link by fusing and analyzing multi-source data to identify and designate enemy targets for rotary strike assets or ground units.[14] TF ODIN's impressive synergy of manned and unmanned airborne ISR resulted in the kill or capture of over 2,500 enemy forces in its first year of operation. While the UAS elements of TF ODIN's Alpha Company often receive the most praise, the manned ISR aircraft in Bravo Company were the only assets that could provide and immediately analyze crucial multi-sensor FMV, SIGINT, and wide-area target coverage at the same time. A big key to TF ODIN's success was the situational awareness, analytical fusion, and responsiveness of its aircrews to quickly make decisions over the battlespace and coordinate actions with other air and ground assets.[15]

Project Liberty.

In order to satisfy airborne ISR requirements more quickly, the Air Force pursued a similar strategy to the Army's TF ODIN. Less than four months after Secretary Gates' sharp criticism, the Air Force received approval to launch Project Liberty, a rapid airborne ISR effort named after a similarly urgent World War II program to quickly field a fleet of cargo ships.[16] As the Army had done with TF ODIN, the Air Force also turned to a manned platform, the civilian

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[14] Ball and McCutchen.

[15] Thierry Gongora, "The Relevance of Manned, Fixed-wing Aircraft in the Provision of ISR and C2 Support," *The Royal Canadian Air Force Journal* Vol. 2, No. 1 (Winter 2013), 36-37.

[16] John A. Tirpak, "Lifesaving Liberty," *Air Force Magazine* Vol. 94, No. 4 (April 2011), 53.

Hawker Beechcraft Super King Air 350. Militarized variants of the airplane were already in the inventory, and the platform's specifications and proven track record made it a viable platform to complement UASs and larger manned ISR assets already in service. The King Air aircraft were rapidly transformed into MC-12s after being outfitted with sensors for FMV and SIGINT along with secure communications gear and laser designator capability. In June 2009, less than a year after the program started, Project Liberty was flying combat ISR missions in Iraq. Just six months later, MC-12s were also conducting ISR operations in Afghanistan.[17] This remarkable transition from laboratory to battlefield made the MC-12 the fastest fielded U.S. weapon system since the P-51 in World War II.[18] Despite the rapid "off the shelf" hardware acquisition, the Air Force still had to train enough people for the new planes. As war has proven, it is the MC-12's aircrew, not its advanced sensors and communications that makes Project Liberty successful.

When Project Liberty began, "MC-12 aircrews" did not exist. The Air Force used the same initial approach it had taken to finding RPA operators: it borrowed them from other manned platforms. MC-12 pilots started off as a diverse mix of fighter, tanker, cargo, and ISR pilots from across the service who were temporarily assigned to train and deploy with an MC-12 squadron.[19] Similarly, FMV sensor and cryptologic operators were drawn from available pools of qualified aircrew from other manned platforms. As with UASs, demand soon outpaced supply as the manpower sharing approach was not enough to meet and sustain surging requirements. By 2012, the heavily tasked MC-12 had garnered the highest operational tempo of any manned platform in the Air Force.[20] Eventually, a new formal schoolhouse was established at Beale Air Force Base, California to train pure MC-12 pilots and sensor operators. Concurrent with this

[17] Tirpak, 54.
[18] Lt Gen Larry James, "Delivering Decision Advantage." *Air & Space Power Journal* (November-December 2012), 5.
[19] Tirpak, 55.
[20] James, 5.

growth, the increased demand for the skillset of airborne cryptologic operators prompted the creation of a completely new Air Force career field specialty in manned airborne ISR.

Airborne cryptologic operators remain in high demand not only to fly onboard Air Force MC-12s, but also on a variety of other light ISR aircraft in the Department of Defense. This broader overall surge in manned airborne ISR drove the creation of a new training program. In 2009, nearly two years prior to the creation of the UAS training program, the Air Force established the 1A8X2 enlisted career field.[21] "X2s," as they are commonly called, were created as a rapid response to an immediate and emerging need for new aircrew to perform specialized airborne ISR mission duties. They were not viewed as a stop gap or supplement to UAS manpower, but rather as a separate capability purposely built to address the greater Department of Defense need for manned airborne ISR, involving both officers and enlisted personnel from all branches of service.[22] As with UASs and MC-12 pilots, the supply of X2 manpower was quickly exceeded by the relentless demand of ISR requirements across the globe. Consequently, from 2009 to 2014, the number of X2s grew over 550 percent from fewer than 90 to nearly 500 personnel.[23] Today, X2s are one of the most highly deployed specialties in the Air Force, flying aboard a diverse fleet of conventional and special operations forces (SOF) aircraft around the world. Because of the irreplaceable combat capability of human aircrews, manned airborne ISR remains superior to unmanned systems. The story of light manned ISR and the X2 career field growth shows unequivocally that technology alone cannot replace the situational awareness and flexibility of humans flying in the battlespace.

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[21] CMSgt Arthur E. Croteau, Jr., USAF 1AX Functional Manager, e-mail to author, December 16, 2014.
[22] SMSgt Scott J. Swanson, USAF 1A8X2 Functional Manager, e-mail to author, December 22, 2014.
[23] *Ibid.*

Chapter 4. Man vs. Machine

Some of the limitations in using RPAs is that you're trying to develop situational awareness through a very narrow aperture view as opposed to having a pilot over the battlefield looking and using the human brain sensor.

General Mark A. Welsh, III, Chief of Staff of the Air Force, January 15, 2015

It's November 20, 2013 and bad weather is rolling in over much of northeastern and central Afghanistan. Visibility and cross-winds have gotten so bad that unmanned aerial system (UAS) operations have been grounded, because the unmanned platforms cannot operate in these weather conditions. Meanwhile, the intelligence, surveillance, and reconnaissance (ISR) aircrew of a manned special operations forces (SOF) platform continues preparations for their combat ISR mission. The Taliban and Al Qaeda historically use bad weather as cover to conceal their movements and activities, and tonight's mission against a top HVI target is deemed of high enough priority for the crew to fly the mission despite the level of risk imposed by the weather. The crew takes off as scheduled, but is immediately forced to change their flight route multiple times to avoid dangerous pockets of turbulence and lightning along the way to their target area.

After arriving on-station, the crew works as a team with ground parties to adjust their flight parameters to optimize target coverage, avoid weather, and stay clear of mountain peaks rising over 10,000 feet. Some communication systems are affected by the weather, so the crew uses alternate means onboard the aircraft without impairing the mission. In addition to their weather radar and other sensors, the crew routinely conducts visual scans for pockets in the clouds and to monitor the approach of a new line of thunderstorms forming nearby. Despite the hazardous conditions, the crew successfully correlates their objective and prepares for kinetic strike options. While analyzing the target area through onboard sensors and externally received information, the crew determines the objective is close to civilians and works alternate options with the ground

team to avoid collateral damage. After completing their mission, the crew lands safely after again dodging weather and terrain on the way back to base. Given the number and scope of the challenges on this mission, only a human aircrew has the situational awareness and flexibility to successfully perform in this kind of complex operational environment.

In the U.S. special operations community, the fact that "humans are more important than hardware" is one of the best known of five simple statements called SOF truths. It means that highly trained human special operators are more valuable than gear and technology. As shown by the SOF ISR aircrew in the previous example, it also means that war requires humans to make tough decisions and find ways to get the mission done. It is this human element that is central to the strength and continued importance of airborne ISR, especially when those humans are close to the fight. Even though UASs are (remotely) operated by humans, their crews do not have the same kinesthetic awareness that ISR aircrew have from flying in the battlespace.[1]

Risk and Survivability.

The respective strengths and limitations of manned and unmanned systems may change depending on the nature of the environment or the circumstances of the mission. For example, the risk to human aircrews is often cited as an inherent limitation of manned aircraft and a predetermined strength of unmanned assets. While the majority of manned ISR assets may not currently have sufficient defensive suites to fully operate in contested airspace, testing has been done to evaluate what would be required to do so.[2] Human aircrews also have the inherent sense of situational awareness to see and avoid many visual threats, giving manned ISR aircraft a basic

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[1] Aaron Mehta and Brian Everstine, "Gen. Hostage: Manned, unmanned mix needed in Iraq," *Air Force Times*, Jul 29, 2014, http://www.airforcetimes.com//article/20140729/NEWS04/307290062/Gen-Hostage-Manned-unmanned-mix-needed-Iraq (accessed September 9, 2014).
[2] John Reed, "The Air Force is looking at how to fly prop-driven spy planes in high-threat environments," *Foreign Policy*, May 1, 2013, http://complex.foreignpolicy.com/posts/2013/05/01/the_air_force_is_looking_at_how_to_fly_prop_driven_spy_planes_in_high_threat_enviro (accessed September 9, 2014).

degree of survivability that most unmanned systems do not have. Meanwhile, UASs remain largely unequipped for self defense, especially against advanced enemy air defense systems.[3]

Risk also applies to peacetime airborne ISR operations when most adversaries are less likely to shoot a manned platform because of the political ramifications of killing people outside of a declared armed conflict. That is why, since the hottest parts of the Cold War, the vast majority of airborne ISR missions intercepted by adversary nations do not result in intentional harm or damage (the 2001 Hainan Island incident was assessed as accidental). However, adversaries may be more aggressive toward an unmanned ISR asset since it presents an easier target with far less (if any) outcry if captured, damaged, or destroyed. This was apparent during Operation SOUTHERN WATCH when Iraqi forces engaged Predators, but were more cautious in reacting to known manned ISR flights. It was also evident in the 2011 loss of the RQ-170 UAS mission in Afghanistan brought down by Iran.[4] In the context of war and peace, risk cuts both ways.

In comparing and contrasting the selected strengths and limitations of manned and unmanned airborne ISR, this section focuses on two inherently human aspects that make aircrews superior to unmanned systems: situational awareness and flexibility. Some associated details comprising these factors may be overcome by technology in the future. However, other aspects cannot be replaced by technology because of the indispensability of the human element.

Situational Awareness and Understanding.

For military aircrew, situational awareness comprises what has happened, what is happening, and what might happen in the operational environment. Human aircrews flying in the battlespace with other air and ground players have a distinctly higher level of situational and kinesthetic awareness than UAS ground crews viewing the battlespace from afar. A human

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[3] LGen (ret) Lloyd Campbell, "The Debate: Manned vs. Unmanned," *Frontline Defence Vol. 8, No. 2* (March 2011), 14.

[4] Aaron Church, "Captured, Copied, and Flown," *Air Force Magazine*, Vol. 98, No. 1 (January 2015), 14.

aircrew not only adds more eyes on the target, but they add specialized operators trained to get the right information to the right person at the right time. They recognize changes in the operational environment, anticipate how those changes could affect operations, and make the complex decisions required in combat. Perhaps more accurately put, human aircrew flying directly overhead have greater situational *understanding*. What truly made TF ODIN and Project Liberty so valuable when they arrived in Iraq and Afghanistan was not the advanced sensors or the hardware on the aircraft; it was the people flying in the aircraft who had the intrinsically human ability to analyze and respond to dynamic events in complex operational environments to accomplish combat missions.[5] For all its speed and efficiency, technology cannot replicate the situational awareness and understanding of human ISR aircrews.

ISR aircrews understand what is happening in the operational environment better and faster than a machine or a UAS ground crew.[6] They have equal or better sensor data than UAS crews, and they can enhance it by looking out the window and observing activity in the battlespace to better frame the data collected by their onboard systems. This may seem intuitive, but the simple act of looking outside involves a deeper prioritized understanding of the environment where the aircrew must recognize what is happening now and anticipate what will happen next. Prioritization and anticipation, as inherently human skills that technology cannot match, are crucial when life and death decisions are often made in seconds. Future technology cannot supplant the adaptable and responsive human brainpower of a highly trained and motivated ISR aircrew. There are three components to consider in understanding why ISR aircrews currently have and always will have better situational awareness and understanding than unmanned

[5] Thierry Gongora, "The Relevance of Manned, Fixed-wing Aircraft in the Provision of ISR and C2 Support," *The Royal Canadian Air Force Journal Vol. 2, No. 1* (Winter 2013), 40.
[6] John A. Tirpak, "Lifesaving Liberty," *Air Force Magazine* Vol. 94, No. 4 (April 2011), 53-54.

systems. Depending on advances in hardware and software, the first two of these components may be less pronounced in the future, but the third cannot be replaced by technology.

First, the larger capacity and payloads on manned airborne ISR systems offer more sensors and multi-intelligence collection capability than the majority of current UASs. ISR aircrews see and understand the entire battlespace through a wider, uninterrupted aperture better than UAS crews and analysts who are often thousands of miles away and predominantly focused on a narrow "soda straw" single source full motion video (FMV) view, delayed via satellite relay.[7] In the future, technology such as sensor miniaturization and universal payload adapters may enable UASs to carry sensors more comparable to many manned ISR platforms, but human aircrews will still be able to analyze the information in better context with the operational environment.[8]

The second component to consider is the robust communication suites that ISR aircrews use to help build better situational awareness and understanding than unmanned systems. Aircrews aboard platforms like the Joint Surveillance Target Attack Radar System (JSTARS) and RC-135 use dozens of radios and datalinks to communicate simultaneously with multiple air, ground, naval, and leadership elements throughout the battlespace, fostering faster analysis. Similarly, aircrews on smaller light ISR aircraft like the MC-12 are trained to coordinate with a wider range of players than UASs.[9] As with payload, the future could bring greater UAS capabilities, but technology alone cannot leverage communications the way human aircrew can tailor and prioritize how best to integrate in the changing battlespace. ISR aircrews can also switch to redundant line-of-sight and onboard intercom systems when communications are degraded or fail due to malfunctions, bad weather, or enemy activity. Likewise, the self-contained nature of manned systems permits aircrews to analyze data onboard and continue the mission. This will be

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[7] Gongora, 40.
[8] Mehta and Everstine.
[9] Lt Col Andrew M. Jett, 34th Special Operations Squadron Commander, e-mail to author, January 6, 2015.

critical in the more contested electronic environments of future war where ISR data will not always be remotely accessible due to communication link vulnerability, information exploitation, or degraded capability to send large amounts of data offboard to ground analysts.

The multi-source sensor and communications capability of manned airborne ISR assets further enhances the aircrew's situational awareness and understanding, leading to the third component of onboard analysis. Larger payloads and better communications are not ends by themselves. They simply enhance the superior analysis capability of humans by providing the aircrew with more types of sensor data instantaneously, giving commanders more complete information to make better and timelier decisions.[10] The crew's onboard analysis can be further enhanced through cross-cueing with other ISR assets to bring in complementary imagery intelligence (IMINT), signals intelligence (SIGINT), or measurement and signature intelligence (MASINT) to build a more accurate assessment of the environment. Technology, such as automation, may enable unmanned systems to *process* ISR data faster than manned assets, but only humans can *analyze* that data because it requires judgment. Future advances in automation and data processing will make human aircrews better at analyzing the operational environment, but analysis itself cannot be automated or replaced by technology.[11]

Most importantly from these three components, only humans have the situational awareness and flexibility to recognize changes, reprioritize efforts, and adapt operations as the mission evolves. This was showcased in the SOF ISR mission vignette at the beginning of the chapter, and it will be crucial to successful airborne ISR in future war. Humans will always be better than machines at recognizing which piece of information they need at which time based on their situational understanding of the environment. This makes ISR aircrews superior to unmanned

[10] Gongora, 41.
[11] Henry Canaday, "Automating Intelligence," *Tactical ISR Technology* Vol. 3, No. 2 (August 2013), 22.

technology systems in rapidly fusing and analyzing multi-source data to create actionable intelligence and quickly pass it to the right people in the right places at the right times.

While future technology offers the potential to reduce many of the current limitations of unmanned systems addressed above, it is dependent on sufficient funding and resources to develop, test, and equip the growing fleet of UASs. In an increasingly competitive and resource constrained fiscal environment, there are no guarantees that all or even most of the proposed advances will come to fruition. The challenge of defense budget prioritization is evident in the recent congressional deliberations over U-2 and Global Hawk modernization and operating costs.[12] Regardless of future unmanned airborne ISR technology, the data can only be processed, not analyzed, onboard the aircraft. The ultimate value of the raw data still hinges on good communication links and sufficient bandwidth to pass the data offboard for human analysis. In a degraded or contested environment, that data may be delayed, corrupted, or unavailable on the ground. This situation could waste precious time (at best) or cause dangerous misinformation (at worst) that can be mitigated by the aircrew of a manned ISR asset. Achieving better situational awareness and understanding through immediate human analysis (enhanced by technology) makes manned airborne ISR more responsive than UASs and gives them greater flexibility to accomplish additional tasks and missions in the battlespace.

Flexibility and Responsiveness.

Manned aircraft became central to addressing the airborne ISR shortfalls that Secretary Gates highlighted in 2008 because they have more flexibility and responsiveness than UASs. This flexibility is observed through a combination of human and technical aspects of manned ISR assets that drives their ability to successfully execute a wider variety of missions across a more diverse operational environment. It was evident from the start of the airborne ISR surge when

[12] Marc V. Schanz, "Spy Eyes in the Sky," *Air Force Magazine* Vol. 96, No. 3 (March 2013), 32.

manned assets demonstrated greater deployability by getting to theater faster than UASs. Manned ISR aircraft can often "self deploy" to tasked operating areas faster than UASs, which require more strategic airlift support to get in theater. Depending on the environment, manned ISR may require a smaller initial support footprint, especially during rapid response operations, and they can typically transition from deployment to full mission capability faster than UASs.[13]

When deploying to theater, manned ISR assets often have greater flexibility for operating locations. While larger manned platforms like the JSTARS or RC-135 need established runways and more extensive support facilities, smaller platforms can use a wider range of locations. Since most of these light ISR assets have more durable airframes than the medium-altitude UASs like the Predator and Reaper, they can often operate from more austere airfields and smaller facilities than UASs.[14] The expanded basing ability of many manned ISR aircraft can also help mitigate their relative lack of endurance and range by placing them closer to the target areas, enabling increased sortie generation and ISR coverage.[15] Manned ISR assets can also offer greater basing flexibility in politically sensitive locations. While UASs at an airfield can be a telltale sign of military (especially U.S.) presence, many manned ISR platforms can appear more like normal civilian traffic. This can help prevent undue attention and bolster operational security and force protection.[16] Deploying manned ISR assets to foreign fields also presents opportunities for host nation personnel to fly onboard, fostering better partner integration.

Once deployed, manned ISR assets are and will remain more flexible in the operational environment than their unmanned counterparts. They have greater operating tolerances in weather conditions such as rain, icing, and winds than UASs. Manned systems are built around

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[13] Gongora, 42-43.
[14] *Ibid.* 43.
[15] *Ibid.* 41.
[16] *Ibid.* 43.

proven airframes and redundant collection and communication systems that can be troubleshot and fixed inflight by the aircrew. Having humans onboard maximizes the ability of manned ISR assets to operate more freely in both military and civilian airspace than current or future UASs. They also have additional onboard systems that UASs do not such as weather radar and traffic collision avoidance systems to help them safely operate with other aircraft. This gives manned ISR assets the flexibility to fly under both visual flight and instrument flight rules to accommodate changing conditions during sorties. Despite a 2012 executive law directing the Federal Aviation Administration to expand airspace for UASs by September 2015, progress has been slow.[17] UASs remain limited, especially in more congested domestic and foreign host nation airspace. Even under tightly controlled military airspace that may help unmanned aircraft operations, UASs typically require additional control and deconfliction measures. Technology could reduce many of these limitations in the future, but technical advances will not be enough for UASs to replicate the strengths of onboard human situational awareness and responsiveness.

Forward deployment enables ISR aircrews to live and work with the units they support in combat, fostering better trust and relationships for close coordination and integrated planning.[18] Geographically separated UAS crews do not have the same flexibility in their battle rhythm. As a result, UASs often use different crews for planning and execution due to different time zones and mission timing. The longer missions of UASs may not align with deployed operations to ensure the same crews plan and work with the same units each day.[19] The crews controlling the UAS flight systems are subject to most of the same crew endurance rules as actual aircrews, so the advantage in loiter time may be offset somewhat by the associated manpower requirement.

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[17] John Horgan, "The Drones Come Home," *National Geographic*, March 2013, http://ngm.nationalgeographic.com /2013/03/unmanned- flight/horgan-text (accessed September 15, 2014).
[18] Tirpak, 54.
[19] Lt Col Andrew M. Jett, 34th Special Operations Squadron Commander, e-mail to author, January 6, 2015.

This can present planning and execution challenges, especially to the Air Force, which operates most of its UASs via a global distributed architecture. Conversely, the Army prefers a more decentralized structure to put its UAS crews closer to the forces they are supporting.[20] No matter how future technology may "shrink" the distance between UAS crews and deployed forces, it cannot replace the face-to-face human interaction that is so important in war.

Command and Control Integration.

Because of their inherent capabilities and closer interaction at deployed locations, human aircrews on manned ISR aircraft can perform more complex tasks and missions than UASs. ISR aircrews can transition quickly from providing overwatch to scanning routes to supporting direct action assaults, all while putting their aircraft and sensors in optimum position and maintaining close communications with multiple assets. UAS crews are also trained to do this, but ISR aircrews can close this information and decision loop faster, enabling more effective operational collaboration.[21] Greater synergy further enables manned airborne ISR to perform command and control (C2) functions for a greater range of air and ground element, improving joint combat effectiveness throughout the battlespace.[22]

As the Iraq and Afghanistan theaters gained more assets, airborne C2 became key to effective ISR. Larger manned assets like JSTARS were designed to perform both ISR and C2, but the influx of smaller manned and unmanned assets highlighted the need for more collaboration in the battlespace.[23] Today, small light ISR like the MC-12 are invaluable in performing specialized roles to control other assets in the "air stack" during ISR operations. In Afghanistan, joint

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[20] Robert W. Moorman, "ISR: Manned vs. Unmanned," *C4ISR Journal* (June 2009), 30.

[21] Spencer Ackerman, "Forget the Drones: Executive Plane Now an Afghanistan Flying Spy," *Wired*, August 11, 2010, http://www.wired.com/2010/08/executive-plane-becomes-flying-spy- in-afghanistan/ (accessed September 8, 2014).

[22] Gongora, 41.

[23] John M. Loh, "Fly More Joint STARS: The key to effective ISR in the war zones is command and control," *Air Force Times*, June 2, 2008, ProQuest LLC, 2014 (accessed September 8, 2014).

operations centers and ground units often leverage ISR aircrew to conduct Air Warden duties that range from procedural airspace and sensor deconfliction to troops-in-contact support. As Air Warden, ISR aircrews direct the sensors and positions of other manned and unmanned assets, freeing the ground forces commander from the need to keep tight control of ISR aircraft.[24] While UASs bring important capabilities as part of an ISR stack, they lack the awareness and onboard analysis needed to perform Air Warden C2, especially during dynamic ground combat operations.

The elements that make an asset well-suited for C2 also apply for more focused tasks such as targeting and direct action operations. Having the capability to analyze and synchronize ISR and kinetic efforts from multiple assets to make decisions shaping combat operations is one of the main reasons ground forces often report they prefer working with the crews of manned airborne ISR assets over UASs.[25] During recent operations in Afghanistan, many ground teams have required the presence of a manned ISR asset overhead to analyze the battlespace and rapidly respond to emerging targets during certain missions. The uniquely human ability to analyze and respond to the environment makes manned airborne ISR crucial for future war.

[24] Lt Col Andrew M. Jett, 34th Special Operations Squadron Commander, e-mail to author, January 6, 2015.
[25] Tirpak, 52.

Chapter 5. Future Airborne ISR

It pisses me off when (people) say the Air Force cut it (U-2). I'm only losing the U-2 because I was directed to buy the Global Hawk (UAS), and the only way I can afford to buy Global Hawks is to cut the U-2.

General Mike Hostage, USAF, July 29, 2014

Pivot to the Pacific.

If history has an enduring lesson, it is that one must understand the past in order to avoid repeating mistakes in the future. While unmanned aerial systems (UAS) like the ubiquitous Predator and the menacing Reaper have become the iconic technologies of American airborne intelligence, surveillance, and reconnaissance (ISR) over the last decade, there is no guarantee these same capabilities will transfer neatly into future war. History offers a potentially analogous lesson between the 1970s UAS transition from Vietnam to Europe and the upcoming transition from Afghanistan to the Pacific. The U.S. enjoyed air superiority in both theaters which allowed unhindered launch, flight, and recovery of UASs. In Vietnam, this effectively masked genetic limitations of UASs that were later exposed by European weather and Soviet air defenses. Since UAS technology tends to rise and fall in cycles, another possible downswing may be on the horizon as the U.S. pivots to the Pacific.[1] Furthermore, the steady decrease of today's overseas contingency operations (OCO) funding, a primary budget source for the Global War of Terror (GWOT), could have similar effects on future UAS technology as the constrained post-Vietnam budget had on UAS development in the 1980s.[2] Future airborne ISR requirements must be carefully considered to prevent a similar setback in the post-Afghanistan years.

Based on former Secretary Gates' defense budget recommendations in 2009 and ongoing

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[1] Titus Ledbetter, III, "UAS Advancement Could Decline After Withdrawal from Afghanistan, Iraq" *Inside the Pentagon's Inside the Air Force* Vol. 21, No. 28 (July 16, 2010), ProQuest LLC, 2014 (accessed September 8, 2014).

[2] COL Tim Baxter, "Steering Army UAS Programs Through Uncertain Times," *Tactical ISR Technology* Vol. 3, No. 2 (August 2013), 19.

acquisition plans in Congress, both manned and unmanned ISR will increase in the future. Upgrades and modernizations are planned for venerable manned ISR aircraft like the U-2 and the Joint Surveillance Target Attack Radar System (JSTARS). To underscore the criticality of 1A8X2 aircrew, the Air Force received congressional approval to maintain an unprecedented 150 percent manning level above normally authorized manpower numbers. Based on projected future demands, those numbers should not decrease over the next five to ten years.[3] Likewise, the growth of UAS manpower is also not expected to change anytime soon, although the Air Force may expand RPA pilot candidates to include enlisted personnel as the other services have.

The Human Element and Future Technology.

Future technology, such as automation and artificial intelligence, could potentially signal a paradigm shift in airborne ISR, but machines will not be able to replicate the brainpower and motivation of highly trained human aircrews.[4] Machines also inherently lack the awareness and judgment required to make life and death decisions. Relying on technology to autonomously conduct lethal targeting carries extreme risk and ethical consequences. In July 1988, the automated Aegis system onboard the *U.S.S. Vincennes* misidentified Iran Air Flight 655 as a hostile Iranian F-14 which was shot down, killing 290 civilians.[5] In March 2003 during OIF, dependence on automation in a U.S. Patriot missile battery was cited as a causal factor in the tragic fratricides of a U.S. F/A-18C and a British Tornado that the system misidentified as incoming Iraqi rockets.[6] Even if future technology can better distinguish between target types,

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[3] SMSgt Scott J. Swanson, USAF 1A8X2 Functional Manager, e-mail to author, December 22, 2014.
[4] Manjeet Singh Pardesi, "Unmanned Aerial Vehicles/Unmanned Combat Aerial Vehicles," *Air &Space Power Journal*, Fall 2005, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj05/fal05/pardesi.html (accessed September 9, 2014).
[5] P.W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin Books, 2009), 125.
[6] Joe Pappalardo, "The Future For UAVs in the U.S. Air Force," *Popular Mechanics* (February 26, 2010), http://www.popularmechanics.com/technology/aviation/military/4347306 (accessed September 15, 2014).

machines alone cannot deal with additional complicating factors such as collateral damage, rules of engagement, and the inherent fog and friction of human warfare. Hunting elusive targets, such as high value individuals (HVI), in complex environments have pushed humans and technology in the ISR targeting cycle as never before.

Sensors are Shooters.

In 1991, Iraqi Scuds seen in U-2 imagery were gone before strike assets could respond. In 1999, a Predator could find mobile Serbian artillery in Kosovo, but it could not strike it. The need for armed ISR came to a head in 2000 when a tall, unidentified man matching the general description of Osama bin Laden was observed by unarmed Predators over Afghanistan.[7] As a result, the dividing line between sensor and shooter in traditional ISR "sensor-to-shooter" operations is less definitive. Today, nearly every strike aircraft carries a targeting pod which can double as a "non-traditional" ISR sensor with full motion video (FMV). The advent of laser designators and weapons on ISR aircraft has further shifted the sensor-to-shooter paradigm. In many cases now, the sensor *is* the shooter. Former Deputy Chief of Staff for Air Force ISR, Lieutenant General David Deptula, characterized this shift as a cultural ISR transformation from "farming" to produce information to "hunting" the enemy.[8] The shift is especially pronounced in HVI man-hunting, further underscoring why humans are irreplaceable in future airborne ISR.

HVI man-hunting is one of the most sensitive operations in the GWOT, not just because of the tactics and technologies involved, but because of the nature of the targets. Terrorists and insurgents look like the rest of the domestic population. They wear the same traditional clothing, frequent the same markets and mosques, drive the same vehicles, and communicate via the same commercial networks. Being armed or unarmed is not necessarily a good discriminator, either,

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[7] Paul J. Springer, *Military Robots and Drones* (Santa Barbara: ABC-CLIO, LLC, 2013), 194.

[8] Lt Gen David A. Deptula, "Air Force ISR Operations: Hunting versus Gathering," *Air & Space Power Journal* 24, No. 4 (Winter 2010), 13.

especially in places like Afghanistan where much of the population owns guns. As the SOF ISR mission example in the last chapter discussed, ISR aircrew are well suited to conduct HVI man-hunts and dynamically respond to changes in the environment. Unmanned machines may provide valuable persistent ISR coverage and faster data processing to help find HVIs, but they cannot discern intent or replicate human abstract reasoning. Despite future advances in technology, this is unlikely to change for at least decades, and it is a major reason why there must be a mixed fleet of manned and unmanned airborne ISR paired together in future war.[9]

Flight Plan for a Mixed ISR Fleet.

There is ample historical precedent for a mixed airborne ISR fleet dating back to the closing years of Vietnam with Lightning Bugs and RF-4C Phantoms. Task Force ODIN achieved remarkable success operating UASs and manned ISR aircraft together to hunt improvised explosive devices (IED) in Iraq. The 9th Reconnaissance Wing at Beale Air Force Base, California conducts co-located primary training and operations for the U-2 and RQ-4 Global Hawk fleets, resulting in more effective operations for both.[10] Future mixed airborne ISR fleets may also include optionally manned systems to further combine manned and unmanned strengths and increase employment flexibility. Optionally manned ISR assets could be especially useful during operations with partner nations or in airspace that requires an onboard aircrew.[11]

Manned and unmanned ISR aircraft routinely operate in the same target areas in the GWOT, but differing priorities and apportionments limit integrated planning and direct communication. As a result, much of the operational integration is left to the systems' respective crews or proactive ground controllers.[12] Thanks to the initiative of human ISR operators, this "ad hoc"

[9] Springer, 62.
[10] Marc V. Schanz, "Spy Eyes in the Sky," *Air Force Magazine* Vol. 96, No. 3 (March 2013), 32.
[11] Ledbetter.
[12] Lt Col Andrew M. Jett, 34th Special Operations Squadron Commander, e-mail to author, January 6, 2015.

approach results in some tactical success, but it would be much more effective if incorporated during operational planning. The emergence of manned-unmanned teaming concepts presents a more effective way to combine manned and unmanned ISR in future war.[13] By building on the Air Warden model, for example, a JSTARS aircrew could command and control a flight of UAS "wingmen." They could dynamically re-task the UASs to identify radar tracks, designate targets for strikes, and push information to air and ground forces.[14] These kinds of operations were effective in Iraq when JSTARS, Global Hawks, and Predators played a key role in destroying Republican Guard units and suppressing Scuds.[15] In Afghanistan, manned light ISR aircraft and Reapers perform route scans, base defense, and HVI man-hunting. In all cases, it is the presence and performance of the ISR aircrew over the target that makes the difference.

Manned airborne ISR will remain indispensable in future war because the inherent situational awareness and flexibility of human aircrew cannot be replaced by machines. It is also highly unlikely that technology, especially in a resource constrained fiscal environment, will overcome all the technical challenges that limit UASs. Airborne ISR in future war must be done by a mixed fleet of manned and unmanned assets to successfully execute diverse sets of missions in increasingly complex operational environments where there is no longer a clear doctrinal divide between sensors and shooters. Using manned and unmanned ISR together effectively combines the strengths of both systems, creating greater synergy through complementary capabilities.

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[13] Baxter, 19.

[14] John M. Loh, "Fly More Joint STARS: The key to effective ISR in the war zones is command and control," *Air Force Times*, June 2, 2008, ProQuest LLC, 2014 (accessed September 8, 2014).

[15] Raghu Rajan, "Are the Days of the Manned Combat Aircraft Numbered?" *Indian Defence Review* Vol 27.1 (March 2012). http://www.indiandefencereview.com/author/airmarshalraghurajan/ (accessed September 9, 2014).

Chapter 6. Conclusion

What we've been told from the field is we don't want all unmanned craft. There's something about manned platforms. There's something about the relationship that develops between the people in the airplane and the people on the ground, because you're not going to leave the people on the ground until you're out of fuel or out of bullets.

Maj. Gen. Bradley A. Heithold, USAF, October 21, 2009

The main thing that is certain about future manned and unmanned airborne intelligence, surveillance, and reconnaissance (ISR) is that it will continue to be in high demand across a wide spectrum of operational environments around the world. The ultimate size, composition, and nature of the future airborne ISR fleet are still being debated by analysts, planners, and even the highest levels of the U.S. government, but it will undoubtedly include human aircrews. The previous chapters have discussed the respective strengths and limitations of manned and unmanned ISR systems, and their combat performance in Iraq and Afghanistan. The paper has even discussed some ways in which future technology in unmanned aerial systems (UAS) could make them technologically equal to many manned ISR assets. However, no amount of technology can replace the situational awareness, decision reasoning, and flexibility of humans. That is why human ISR aircrews will remain indispensable in future war.

In 2008, the scourge of improvised explosive device (IED) networks in Iraq and Afghanistan and former Secretary of Defense Robert Gates' critical "pulling teeth" speech drove the largest airborne ISR surge in U.S. military history. UASs were in high demand for their mission endurance and persistent full motion video (FMV) coverage, but unmanned systems proved unable to surge as quickly or effectively as manned platforms. As the Army did with TF ODIN, the Air Force created Project Liberty and established a new manned ISR training program. The broader effort included personnel from all branches of service, creating an immensely responsive manned ISR force driven by the unmatched combat capability of human aircrews.

Future airborne ISR will require a mixed fleet of both manned and unmanned assets to leverage the strengths found in both systems. These are complementary capabilities that must be employed together to maximize airborne ISR effectiveness. UASs and technology will empower human aircrews, not replace them. War is a timeless part of the human condition, and it will always require people on and over the battlefield. Technology is nothing more than hardware and machines that simply follow predetermined sets of inputs and instructions to react to specific events. Future advances, like automation and artificial intelligence, may enhance technology to increase data processing and recognition, but technology cannot analyze the data or anticipate changes in the environment. War is fraught with inherent uncertainties and rapid changes that can only be understood and fought by human beings.

In this context, human ISR aircrew must be in position to influence and make the critical decisions in combat because only they have the situational awareness and flexibility demanded by complex operational environments. Life and death cannot be based on computer algorithms that will default to the most logical solution regardless of the fog and friction of war. In this sense, it may sometimes take an "illogical" decision made by a human ISR aircrew to achieve the best outcome in war. Humans will always be needed as ISR aircrew to make decisions that machines cannot. In the dynamic world of future airborne ISR where sensors can instantly become shooters, the best position to make critical decisions is in the air over the target. As Confederate General Robert E. Lee reportedly said after witnessing the carnage during the Battle of Fredericksburg in 1862, "It is well that war is so terrible, lest we should grow too fond of it." War is a human condition. Keeping humans directly engaged in war at all levels may be the best constant reminder of why, in the future, it should continue to be the last resort.

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Vita

Lt Col Jared B. Patrick (BS, University of South Carolina; MS, National Defense Intelligence College; Air Command and Staff College; Air War College) is a career intelligence officer who has served in a variety of operational assignments including targeting, fighter operations, airborne command and control, and airborne ISR. He is a Senior Officer Aircrew member with over 2,100 flight hours, including over 1,300 combat hours, on multiple aircraft types. He has deployed numerous times in support of Operations ALLIED FORCE, SOUTHERN WATCH, IRAQI FREEDOM and ENDURING FREEDOM, including six tours flying missions in Iraq and Afghanistan. His most recent assignment was as the Commander of the 25th Intelligence Squadron at Hurlburt Field, Florida where he led over two hundred and fifty personnel and two overseas Detachments delivering airborne threat warning and precision geo-location to Air Force Special Operations Command and joint special operations forces conducting high-risk missions worldwide for the SECDEF and U.S. Special Operations Command.